Variation in Management of Community-Acquired Pneumonia Requiring Admission to Alberta Hospitals

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TABLE OF CONTENTS

Summary 1
Introduction 2
Methods 3
Inclusion Criteria: 3
Exclusion Criteria: 3
Categorization of Hospitals: 4
Hospital Costs: 4
Clinical Path Costs: 5
Outcomes were defined as: 5
Statistical Analysis 5
Results 7
Discussion 8
References 12
Figure Legend 16
Table 1 – Utilization of acute care hospitals for treatment of adults with community-acquired pneumonia in Alberta 17
Figure 1 – Age-sex adjusted separation rates per 1,000 for community-acquired pneumonia in the seventeen Alberta health regions during 1994/95 to 1998/99 18
Figure 2 – Monthly variation expressed as percent annual hospital admissions for community-acquired pneumonia during 1994/95 to 1998/99 18
Table 2 – Patient demographics for community-acquired pneumonia in Alberta during 1994/95 to 1998/99 and for those patients with pneumonia who either died in hospital and within one year of hospital discharge after treatment for pneumonia 19
Table 3 – Utilization of hospital care for community-acquired pneumonia by hospital type during 1994/95 to 1998/99 20
Table 4 – Multiple logistic regression for any re-hospitalization between zero to thirty days after index pneumonia date separation 21
Table 5 – Multiple linear regression for log length of hospital stay 22
Appendix 23
Table: Recipient region use of hospital care for community-acquired pneumonia during 1994/95 to 1998/99 23
Table: Service region use of hospital care for community-acquired pneumonia during 1994/95 to 1998/99 24
Biographies 29
Yan Jin, M.A. 29
Thomas J. Marrie, M.D. 30
Keumhee C. Carrière, Ph.D. 31
Gerry Predy, M.D. 32
Chris Houston, CCHRA(C) 33
Kathleen Ness, M.F.H. 34
David Johnson, M.D., S.M., M.B.A. 35

SUMMARY

Previous studies have shown small area variation in the rate of admission to hospital for patients with community-acquired pneumonia. We used an administrative database to determine factors influencing the rate of hospitalization and length of stay for adults who were admitted to hospital for the treatment of community-acquired pneumonia in Alberta from April 1, 1994 through to March 31, 1999. Age-sex adjusted separation rates were significantly below the provincial average in all urban regions. Separation rates for residents in all other rural regions and four of five regions with a regional hospital were significantly higher than the provincial average. The relative risk for a longer length of stay in hospital was twenty-two percent greater in regional hospitals and about thirty percent greater in urban hospitals compared to rural hospitals. Quality improvement initiatives for community-acquired pneumonia should be targeted towards reducing the admission rate at rural hospitals and shortening the length of stay at urban and regional hospitals. Rural hospitals would likely benefit from a protocol to help with the admission decision and urban hospitals from a program to reduce length of stay.

INTRODUCTION

The current escalating costs of providing health care services in Canada have been called unsustainable. Some have suggested that the problem of escalating costs is due to inefficient allocation of existing resources [1]. If efficiency is important, it must be directed towards common diseases that have a large economic burden and where practice variation rather than case mix or severity drives the utilization of resources [2]. Strategies to increase efficiency require case management or clinical pathways that are effective in altering costs or outcomes [3] and where practice variation is provider- or institutionally-based rather than related to patient preferences [4].

Community-acquired pneumonia may be one condition both suitable for quality improvement initiatives [6] and where an impact would potentially have significant implications on resource allocation [8]. Community-acquired pneumonia has an annual incidence of twelve per 1,000 adults of which approximately fifteen percent of cases are admitted to hospital [5]; hospitalization consumes up to ninety percent of direct medical costs for this condition [7]. The thirty-day mortality for pneumonia in adults requiring admission to hospital is fifteen percent [6]. Most studies detailing practice variation or specific interventions have been restricted to teaching hospitals or large community-based facilities [2,3,6]. We were not aware of a study of the variation in hospital care for community-acquired pneumonia within an entire province or state. Information at the provincial or state level is critical in investigating the feasibility of quality improvement initiatives aimed at medium and smaller volume facilities. In these lower volume facilities, knowledge of existing practice variation and costs allow an estimation of the potential for change. The assessment of potential impact is the first step in initiating a quality improvement process. In this study, we classify Alberta hospitals and health regions by number of community-acquired pneumonia cases and assess if anticipated efficiency would make them suitable targets for a quality improvement program.

METHODS

Inclusion Criteria:

Community-acquired pneumonia was defined as the most responsible diagnosis (MRD) or any of the other fifteen diagnosis codes defined to be Type 1 (pre-admit comorbidity) with the ICD-9-CM values of 480.x to 487.x (pneumonia) or 507.x (aspiration pneumonia) excluding 484.x (pneumonia of infectious diseases classified elsewhere) [9-10].

Exclusion Criteria:

1. Not an Alberta resident or not treated in an Alberta acute care facility.
2. Adjacent diagnosis related group (ADRG) defining hospitalization for a surgical procedure.
3. Any previous hospitalization within ten days of incident pneumonia case.

Severity of illness was defined as any of the following:

- Transfer to hospital from a nursing home, long term care or continuing care institution.
- Transfer from another acute care facility as defined by re-admission to hospital for the diagnosis of pneumonia within forty-eight hours of previous discharge.
- Age (65 to 74, 75 to 84, or 85 or more years (age at the fiscal year-end is used)).
- Special care unit admission (defined by each hospital).
- Diagnosis code of respiratory failure or arrest (ICD-9-CM 518.81, 799.1).
- Diagnosis code of hypotension or shock (ICD-9-CM 458.xx, 785.5x).
- Procedure code for ventilation greater than ninety-six hours (ICD-9-CM 96.72).
- Procedure code for dialysis (ICD-9-CM 39.95, 54.98).

Charlson's comorbidity index was calculated using established definitions [11-12]. Length of stay was calculated as days between discharge and admission date. Transfers were attributed to the index admission and cumulative hospital length of stay calculated. Alternate (not acute care)

level of care days were subtracted from the length of stay. All active hospital acute care beds in each year per resident region were surveyed and maintained in the provincial databases. Aboriginals registered with the Department of Indian Affairs and Northern Development are recorded within the Alberta Health Care Premium Registry databank.

Categorization of Hospitals:

All hospitals in Alberta are administered by an autonomous regional board in each of the seventeen health regions. All residents of Alberta enrolled in the public health care insurance plan reside in one of the seventeen health regions. Hospitals admitting patients with community-acquired pneumonia were categorized into five groups on the basis of the average number of separations per year over the five year study period, geographic location, and medical school proximity:

Rural

- Less than fifty cases per year comprising seventy-seven hospitals;
- 50 to 108 cases per year comprising twenty-seven hospitals;

Regional

- Five hospitals located in one of the five non-metropolitan regional health care cities ranging from 67 to 251 cases per year and one high volume rural hospital accounting for 221 cases per year;

Metropolitan

- Seven hospitals located in the metropolitan health regions of Calgary and Capital hospitals ranging from 92 to 813 cases per year;
- Two hospitals located adjacent to medical schools with one hospital located in each of two metropolitan centres ranging from 493 and 610 cases per year.

The rural hospital cut-off values for pneumonia cases of 50 and 108 represented the 50th and 75th percentiles.

Hospital Costs:

In-patient cost per resource group number (RGN) was calculated using the provincially approved methodology as set forth by the Provincial Costing Project and in accordance with the Provincial and National Management Information Systems guidelines [13,14]. Total costs combine allocation and assignment of all direct and indirect costs associated with an in-patient encounter from the time a patient is admitted to the hospital to the time of discharge. All costs were estimated in 1998/99 and assumed similar for all

the study years. The quality of the data reporting of costs in Alberta has been highly ranked by the Canadian Institutes for Health Information [15]. As such, the methodological issues that arise around collection of cost data for the United States [16], in part due to the use of prices rather than costs, and for centres in Canada which cost admissions on the basis of "case-mix grouping", do not arise with the majority of the cost data considered in this analysis.

Clinical Path Costs:

The major incremental cost of the pathway is due to the involvement of a nurse case manager. In the Capital Health Authority, four nurses can follow three thousand patients annually within the city of Edmonton. Assuming labor costs of $70,000.00 per nurse and fifty percent of pathway patients are hospitalized, the clinical pathway cost per hospitalized patient is approximately $95.00.

Outcomes were defined as:

- Separation rate per health region,
- Length of hospital stay per separation,
- Any re-hospitalization between zero to thirty days after index pneumonia date separation excluding re-hospitalization for pneumonia between zero to two days (considered to be a hospital transfer),
- Incident pneumonia case associated with a second pneumonia case within two to ten days of discharge (a pneumonia case between zero to two days of discharge considered to be a hospital transfer), and
- Incident pneumonia case associated with a second incident pneumonia case within eleven to thirty days of discharge.

STATISTICAL ANALYSIS

Age-sex standardized rates and the ninety-five percent confidence intervals were calculated for separation rates. The indirect standardization method was used with 1998/99 provincial age-sex rates (18-34 years old, ten-year increment afterwards up to 74 years old, 75 and over for each sex) as standard rates. In order to calculate standard error for the standardized rates, the patient's age at a fixed date was necessary as a patient may have more than one separation in a year. Age at the year-end is used for the rates and their standard errors. Overall rates between regions and Alberta in any one year and between years for any one region or Alberta were compared using T-statistic [17]. If the T-statistic was significant, individual rate

differences were compared using the overall ninety-five percent confidence interval, while adjusting for multiple comparisons. Multiple comparisons were made when contrasting the four yearly rates to that of the five year average and the seventeen regions to the overall Alberta rate. The age-sex adjusted hospital separation rate is compared between geographically defined health regions by ninety-five percent confidence intervals and the overall provincial rate.

Because of the large sample size and ability to make numerous significant contrasts, only contrasts not analyzed by modelling were made in the descriptive analyses. Seasonal variation was compared using a two-way ANOVA with year and season and their interaction as factors (SAS 8 [SAS Institute Inc. Cary, NC 2000] using generalized linear model least square means [Proc GLM]). Significance was defined as $p < 0.05$.

A forward stepwise selection of factors was used (SAS 8) to determine the order of importance of the factors influencing each outcome variable. For the length of stay analysis, we used the natural log transformation as the data were right skewed. Covariates were age (18-44, 45-64, 65-74, 75-84, 85+), sex, year of separation, per capita number of acute care beds per resident region in each study year, hospital type as defined above, exported case (i.e. service region not equal to recipient region), urban or non-urban resident region, aboriginal treaty status, nursing home transfer to hospital, transfer to another hospital, special care unit admission, diagnosis code of respiratory failure/arrest, diagnosis code of hypotension/shock, procedure code for ventilation greater than ninety-six hours , procedure code for dialysis, and number of comorbid diagnosis (0, 1, 2, >2). The unit of analysis was hospital separation with some patients being hospitalized on multiple occasions per year. We attempted to adjust for correlations in separations within the same subject, but it did not result in substantial difference from those under the assumption of zero correlation. Therefore, we opted to report results of a simpler approach based on multiple linear and logistic models [18,19]. To control the large sample size effect on statistical significance, we used one-third random sample from the separations data for statistical modelling [20]. The results were validated with the entire data to test for bias in the sample.

RESULTS

During the five years of the study, there were 43,642 acute care hospital separations for 36,516 unique patients with community-acquired pneumonia. Patients (n = 4,935) had at least one repeated admission during the five years (separations per patient: mean 1.26; median 1; range 1 to 16). Hospital separations decreased by eight percent in 1995/96 compared to 1994/95 and were still lower than 1994/95 in the last year of our study (1998/99) by four percent (Table 1). The variation over the five study years in special unit admission, designation of alternate level of care, mortality, and thirty-day re-admission was small.

During the study period, age-sex adjusted separation rates for residents in the seventeen health regions were significantly below the provincial average in the two urban health regions (four and ten) and not different from the provincial average in one regional health region [1]. Separation rates for residents for all other health regions were significantly higher than the provincial average (Figure 1). The average number of hospital beds per 1,000 population during the study period was 2.4, 2.5 and 2.3 in rural, regional, and urban regions respectively. The Spearman correlation between the five-year averaged age-sex adjusted separations and hospital beds per 1,000 population in the seventeen health regions was weak at 0.29 ($p>0.05$). The monthly pattern of hospital admissions for each of the five study years are shown in Figure 2. Approximately forty-two percent of all admissions occurred between December to March. Admissions during the winter quarter, January to March, were significantly greater than the other three quarters, which were all similar. Although the yearly total separations were stable over the study period, there was a significantly increasing trend in the winter quarter and a decreasing trend in other quarters leading to significant interactions between season and year. The noted seasonal variation came from the fiscal years 1997/98 and 1998/99, where the winter quarter admissions nearly doubled those of the other quarters.

Demographic features of the study population are given in Table 2. The cohort of patients with community-acquired pneumonia was predominately elderly (mean age = sixty-six years compared to the mean age of forty-four years in the 1998/99 population of adults in Alberta) and sixty-three percent had one or more comorbidities. The all cause in-hospital and one-year mortality rates were 11.6 percent and 26.1 percent, respectively. Mortality was higher for males, the elderly, those patients transferred from a nursing home, and those patients with greater comorbidity and those with severe pneumonia (Table 2).

Compared to rural hospitals, regional and metropolitan hospitals admitted patients with greater severity of illness as demonstrated by greater hospital mortality, cost per case and comorbidity (Table 3). Special care unit admissions were highest in regional hospitals compared to medical school referral hospitals or metropolitan hospitals. Thirty-day re-admissions were higher in rural hospitals compared to all other hospital types. The outcome variable on all cause hospital re-admission was modelled using multiple regression (Table 4) after adjustment for modifying factors described above. The factor of specific interest was hospital type. The estimated odds ratio for hospital re-admission after adjustment for other factors was 0.75 (95 % CI 0.64-0.89) for regional hospitals and 0.82 (95 % CI 0.67-0.99) for metropolitan hospitals compared to rural hospitals. Greater comorbidity and older age increase the relative risk for all cause re-admission. When restricted to re-admissions for pneumonia only, both greater comorbidity and older age also increase the odds of re-admission within two to ten days of hospital discharge. Only comorbidity increases the odds of re-admission for pneumonia between eleven and thirty days of hospital discharge. We do not present these results, but they are available from the authors.

One marker of hospital efficiency (length of stay) was compared among hospital types. Length of stay was relatively similar in Alberta during the five year study period. In general, length of hospital stay increased from rural to regional to urban hospitals. The results of the log length of stay regression are shown in Table 5. After adjusting for other factors, regional and urban hospitals demonstrated a larger estimated relative risk for a longer length of stay compared to rural hospitals.

DISCUSSION

Community-acquired pneumonia is a common reason for hospital admission in Alberta. The annual hospitalization rate of four cases per 1,000 results in 8,500 annual hospital separations at a cost of over forty million dollars. The incidence of community-acquired pneumonia and subsequent hospitalization varies between countries and if clinical or administrative data is used to define the illness [21,22] . The all cause in-hospital mortality rate is twelve percent and one year mortality rate is twenty-six percent. The rate of hospital separations is greater than the provincial average in rural health regions. In contrast, after adjusting for other factors, length of hospital stay is greater in urban and regional hospitals compared to rural hospitals. Utilization analysis may be helpful in targeting quality improvement initiatives specific to the need of different hospitals and health regions. The existing practice environment in urban hospitals may limit hospital admissions. The existing practice environment in rural regions and some health regions with a

regional hospital make the appropriateness of hospital admission a target for quality improvement. Conversely the existing practice environment in urban hospitals make the length of stay (i.e. time between hospital admission and discharge) a more likely target for quality improvement compared to rural hospitals. Regions with regional hospitals have an increased length of stay and most have a higher admission rate. Therefore, the decision to admit and discharge may both be quality improvement targets. Quality improvement targets vary and should be specific to the hospital type and/or geographic location.

Hospital admission for community-acquired pneumonia demonstrates seasonal variation [23] and efforts to improve the appropriateness of admission might be best timed at peak periods. In this manner, total program costs could be distributed amongst other programs with a complimentary seasonal variation (i.e. trauma). Mortality for those hospitalized with community-acquired pneumonia is high which is likely related to its occurrence in those with serious chronic diseases and the elderly [24]. This study does not directly specify what practice differences among rural, regional, and urban hospitals might lead to treatment variations. The number of hospital beds per 1,000 population was not dramatically different among regions nor were hospital beds per 1,000 population correlated to the separation rate. Comparative bed counts may not be reflective of the pressures exerted to fill these beds. Urban and regional hospital beds may have greater pressures exerted because of their use in referred cases from rural regions and medical services not provided in non-tertiary or non-teaching hospitals.

Algorithms to help clinicians decide upon hospital admission and discharge have been devised, validated, and published [3,4,25-28]. These guidelines are robust even in elderly [29] and may decrease mortality [22]. Despite clinical guidelines, considerable variation exists in the treatment of community-acquired pneumonia within larger Canadian hospitals [2]. From the clinicians' perspective, variability in the decision to admit depends upon perceived availability of outpatient intravenous antibiotics, home care, and identification of the low risk patient [4]. Physicians' estimation of pneumonia severity is greater than that obtained using a standardized tool [30]. Physicians believed that diagnostic evaluation, treatment of comorbid illness, completion of standard course of antibiotics, and wait for long term care may delay discharge in clinically stable patients [25]. Patients stay in hospital between two to four days after stabilization [3]. Medical outcomes, however, were similar in patients admitted to hospitals with the shortest length of stay compared to the longest length of stay [31]. A randomized trial in the Alberta Capital Health Region demonstrated an average two-day reduction in length of hospital stay using a clinical pathway [3]. Thus, even if our study did not

adjust adequately for case severity and mix, a decrease in length of stay is possible even for these urban hospitals patients who had the greatest comorbidity. Hospitalization costs in the United States are comparable with those reported in this study (US $5,942.00) with a potential savings of US $680.00 with a one-day length of stay reduction [32].

Small area variation studies such as ours are plagued with the unanswerable question, "Which rate is right?" [33]. In our study, regional differences in separation rates existed. The importance of rate differences and potential for impact upon care received require clinical judgement. Utilization analysis provides a quantification of existing differences: larger in separation rates; less in length of stay; and small with re-admissions. Utilization analysis helps target where the probability of potential change is greater, because variation is greater. However, an overall provincial rate may still be uniformly too high or too low, even though the variation was small.

Our study has several limitations. Hospital separations were greater in regional and rural hospitals and less in urban hospitals. Although community-acquired pneumonia incidence may vary geographically, we also noted that comorbidity increased from rural to urban hospitals. Urban hospitals may be more effective in triaging hospital admissions. Once admitted however, length of stay was greater in urban and regional hospitals compared to rural hospitals. Population-based administrative database research is highly generalizable although limited in clinical details. We attempted to adjust for case severity (hypotension/shock, respiratory arrest/failure, ventilation, special care unit admission, export to another region, transfer to another hospital) and case mix (comorbidity, transfer from nursing home, age, sex) but may not have captured all variation [34]. These variables are likely less reliable than a clinically derived pneumonia index [3]. As well, we have no index for family support which may have varied geographically and impacted upon length of stay. Data about regional variation in the use of influenza and pneumococcal vaccine was unavailable. In particular, influenza vaccine has been shown to reduce the hospitalization rate for pneumonia in the elderly [35].

We believe a quality improvement initiative, targeting appropriateness of hospital admission in rural hospitals and length of stay in urban hospitals, would be beneficial. Either strategy may be applicable to health regions with a regional hospital. A targeted approach may diminish costs compared to a more comprehensive program. The cost per patient in a community-acquired pneumonia clinical pathway Alberta study was $95.00 [3]. Use of clinical decision aids at the time of hospital admission may be reasonable even for smaller rural hospitals. To estimate the potential benefit, a retrospective calculation by hospital chart review of the criteria used in the

admission or discharge of patients with pneumonia would be the next suggested step for the hospital or health region wishing to initiate a community-acquired pneumonia quality improvement process.

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FIGURE LEGEND

Figure 1

Age-sex adjusted separation rates per 1,000 for community-acquired pneumonia in the seventeen Alberta health regions during 1994/95 to 1998/99. Bars indicate ninety-five percent confidence interval and dashed line is provincial average. Rates were adjusted using indirect standardization as described in methods.

Figure 2

Monthly variation expressed as percent annual hospital admissions for community-acquired pneumonia during 1994/95 to 1998/99. Each season consists of three months with winter defined as the months of January to March.

Table 1 – Utilization of acute care hospitals for treatment of adults with community-acquired pneumonia in Alberta

	Year 94/95	Year 95/96	Year 96/97	Year 97/98	Year 98/99	Average during 5 year period
Annual number (percent) of separations	9,141 (21%)	7,726 (18%)	8,260 (19%)	9,149 (21%)	9,366 (21%)	8,728
Age-sex standardized hospital separation rate per 1,000 adults	4.81	3.98	4.14	4.45	4.43	4.36
Percent special care unit admissions	7.46%	8.80%	8.60%	7.88%	8.38%	8.20%
Percent alternate level care designation	1.28%	1.71%	1.80%	2.22%	2.36%	1.88%
Mean (median) length of stay in days	9.46 (6)	8.75 (6)	9.06 (6)	9.04 (6)	9.40 (6)	9.16 (6)
Percent all cause thirty-day re-admissions	15.47%	17.28%	17.72%	17.35%	18.02%	17.15%
Percent of incident pneumonia associated with a second non-incident pneumonia within 2 to 10 days of discharge	2.06%	2.28%	2.20%	2.22%	2.35%	2.22%
Percent of incident pneumonia associated with a second incident pneumonia within 11 to 30 days of discharge	1.55%	1.67%	2.13%	2.06%	1.78%	1.84%
Percent in-hospital mortality	10.4%	11.8%	11.8%	12.2%	11.4%	11.6%
Percent one-year mortality for pneumonia patients	22.7%	26.2%	27.7%	26.8%	26.4%	26.1%
Total hospital costs (in thousand dollars)	$39,327	$35,565	$37,994	$41,625	$42,642	$39,431
Average costs (in 1998/99 dollars) per separation	$4,302	$4,603	$4,600	$4,551	$4,553	$4,518

Figure 1 – Age-sex adjusted separation rates per 1,000 for community-acquired pneumonia in the seventeen Alberta health regions during 1994/95 to 1998/99

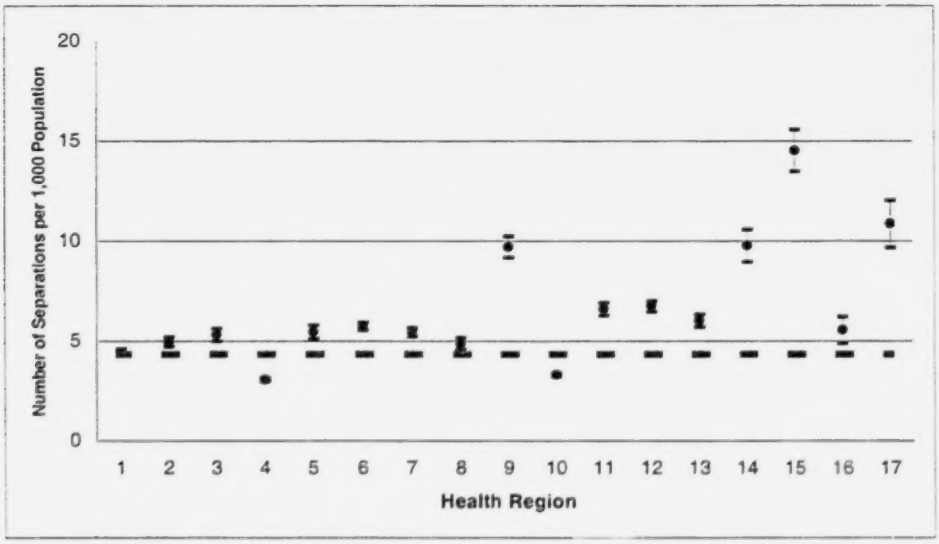

Figure 2 – Monthly variation expressed as percent annual hospital admissions for community-acquired pneumonia during 1994/95 to 1998/99

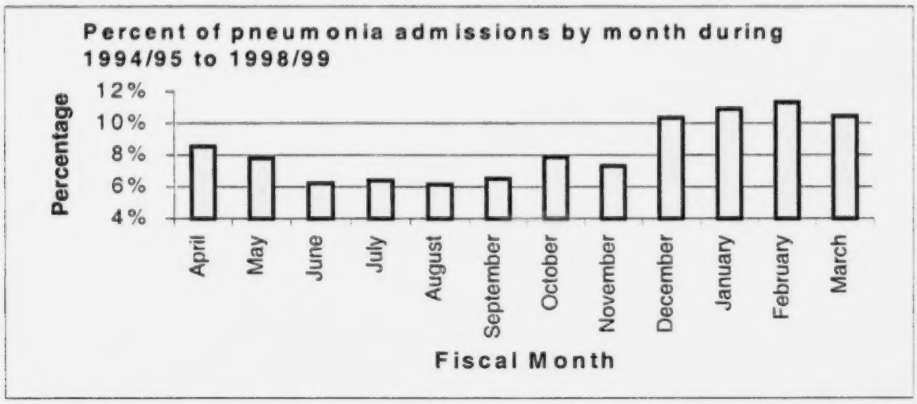

Table 2 – Patient demographics for community-acquired pneumonia in Alberta during 1994/95 to 1998/99 and for those patients with pneumonia who either died in hospital and within one year of hospital discharge after treatment for pneumonia

	All pneumonia separations N= 43,642 n (%)		All cause in-hospital mortality for pneumonia separations N= 4,693 n (%)		All cause one-year mortality for pneumonia separations N= 11,370 n (%)	
Female	21,070	(48%)	1,954	(42%)	4,633	(41%)
Age 18 to 44 years	8,058	(18%)	182	(3.9%)	461	(4.1%)
Age 45 to 64 years	8,441	(19%)	571	(12%)	1,508	(13%)
Age 65 to 74 years	8,664	(20%)	910	(19%)	2,359	(21%)
Age 75 to 84+	11,412	(26%)	1,590	(34%)	3,877	(34%)
Age 85 +	7,067	(16%)	1,440	(31%)	3,165	(28%)
Aboriginal treaty status	2,799	(6%)	29	(0.6%)	240	(2.1%)
Transfer from nursing home	1,531	(4%)	432	(9.0%)	968	(8.5%)
Transfer to another hospital	943	(2%)	1	(0.02%)	315	(2.8%)
Urban region of residence	18,443	(42%)	2,665	(57%)	5,837	(51%)
Exported from home region	5,247	(12%)	510	(11%)	1,387	(12%)
Separation alternate level of care designated	822	(1.9%)	99	(2.1%)	413	(3.6%)
Special care unit admission	3,578	(8.2%)	926	(20%)	1,405	(12%)
Comorbidity (0)	16,316	(37%)	562	(12%)	1,655	(15%)
Comorbidity (1)	14,705	(34%)	1,405	(30%)	3,791	(33%)
Comorbidity (2)	7,937	(18%)	1,477	(31%)	3,374	(30%)
Comorbidity (>2)	4,684	(11%)	1,279	(27%)	2,550	(22%)
Chronic obstructive pulmonary disease	14,363	(33%)	1,510	(32%)	4,060	(36%)
Diabetes	5,403	(12%)	710	(15%)	1,733	(15%)
Malignancy	3,505	(8.0%)	1,053	(22%)	2,439	(21%)
Congestive heart failure	8,492	(19%)	1,618	(35%)	3,682	(32%)
Vascular (acute myocardial infarction, peripheral vascular disease, cerebral vascular disease)	6,319	(14%)	1,440	(31%)	2,738	(24%)
Hypotension and shock	997	(2.3%)	413	(8.8%)	576	(5.1%)
Respiratory arrest and failure	2,027	(4.6%)	877	(19%)	1,183	(10%)
Ventilation for more than 96 hours	617	(1.4%)	259	(5.5%)	326	(2.9%)
In hospital dialysis	282	(0.65%)	75	(1.6%)	135	(1.2%)

Where separations (number and percent) and deaths (number and percent) of those with the specific characteristic are shown. The percent(s) with each characteristic sum to 100% of all separations or deaths respectively when combined with the reference group. A mortality percent larger than the percent separations for each characteristic indicates a mortality rate above the rate for those without that specific characteristic. Note the percent of deaths are by separation in Table 2 while Table 1 is death rate per person.

Table 3 – Utilization of hospital care for community-acquired pneumonia by hospital type during 1994/95 to 1998/99

Hospital type	Number and percent of hospitals in this category	Number and percent of total hospital separations	Percent special care unit admissions	Percent alternate level of care designation	Mean (median) length of stay in days	Average (sd) number of comorbidity	Percent thirty-day re-admissions	Percent in-hospital mortality for pneumonia patients	Average hospital costs (in dollars) per pneumonia separation by hospital category
Rural (less than 50 cases per year)	77 (65%)	9,136 (21%)	2.4%	0.9%	7.52 (5)	0.76 (0.91)	18.2%	6.7%	$3,501
Rural (50 to 108 cases per year)	27 (23%)	9,367 (21%)	4.4%	1.5%	7.62 (5)	0.81 (0.95)	18.5%	8.0%	$3,542
Regional	6 (5%)	5,828 (13%)	14.3%	1.6%	9.46 (6)	1.1 (1.1)	16.3%	12.1%	$4,551
Urban (metropolitan)	7 (6%)	13,795 (32%)	9.5%	2.4%	10.58 (7)	1.32 (1.18)	15.5%	15.2%	$5,250
Urban (hospitals in proximity to a medical school metropolitan)	2 (1%)	5,516 (13%)	14.7%	3.1%	10.56 (7)	1.36 (1.22)	18.0%	15.1%	$5,991

Table 4 – Multiple logistic regression for any re-hospitalization between zero to thirty days after index pneumonia date separation

	Odds ratio	95 % Confidence Interval
Comorbidity (0)	Reference	
Comorbidity (1)	1.65	1.46 – 1.87
Comorbidity (2)	2.28	1.97 – 2.64
Comorbidity (greater than 2)	2.52	2.12 – 3.01
Urban region of residence	0.82	0.69 – 0.98
Special care unit admission	1.60	1.35 – 1.90
Transfer from home region	1.36	1.18 – 1.56
Rural (less than 50 cases per year)	Reference	
Rural (50 to 108 cases per year)	NS	
Regional	0.75	0.64 – 0.89
Urban (metropolitan)	0.82	0.67 – 0.99
Urban (metropolitan hospitals in proximity to a medical school)	NS	
Female	0.84	0.76 – 0.92
In hospital dialysis	2.29	1.36 – 3.88
Age 18 to 44 years	Reference	
Age 45 to 64 years	NS	
Age 65 to 74 years	1.24	1.05 – 1.47
Age 75 to 84+	1.31	1.11 – 1.55
Age 85 +	1.44	1.20 – 1.72
Hypotension and shock	1.45	1.03 – 2.03
Aboriginal treaty status	1.26	1.05 – 1.52
Transfer from nursing home	0.74	0.55 – 0.99

The order of factors entry into the model is from top to bottom and indicates their relative order of significance

Table 5 – Multiple linear regression for log length of hospital stay

	Relative Risk	95 % Confidence Interval
Age 18 to 44 years	Reference	
Age 45 to 64 years	1.25	1.20 – 1.30
Age 65 to 74 years	1.48	1.42 – 1.54
Age 75 to 84+	1.66	1.60 – 1.74
Age 85 +	1.91	1.82 – 2.00
Comorbidity (0)	Reference	
Comorbidity (1)	1.17	1.13 – 1.21
Comorbidity (2)	1.40	1.35 – 1.46
Comorbidity (>2)	1.58	1.50 – 1.66
Transfer to another hospital	2.25	2.07 – 2.45
Rural (less than 50 cases per year)	Reference	
Rural (50 to 108 cases per year)	NS	
Regional	1.22	1.17 – 1.28
Urban (metropolitan)	1.28	1.24 – 1.33
Urban (metropolitan hospitals in proximity to a medical school)	1.27	1.21 – 1.34
Special care unit admission	1.29	1.22 – 1.37
Mechanical ventilation greater than 96 hours	1.93	1.67 – 2.23
Respiratory failure and arrest	1.33	1.23 – 1.44
Aboriginal treaty status	0.85	0.81 – 0.90
Hypotension and shock	1.21	1.09 – 1.35
Female	1.05	1.02 – 1.07
Transfer from nursing home	0.90	0.83 – 0.97
In hospital dialysis	1.20	1.01 – 1.43

The order of factors entry into the model is from top to bottom and indicates their relative order of significance

APPENDIX

Table: Recipient region use of hospital care for community-acquired pneumonia during 1994/95 to 1998/99

Recipient region	Hospital separations for pneumonia per 1,000 population (crude rate)	% Special care unit admissions for pneumonia cases	% Alternate level of care designation for pneumonia cases	Average (standard deviation) number of comorbidity for pneumonia cases	Mean (median) length of hospital stay in days for pneumonia cases	Percent thirty-day re-admissions after discharge for pneumonia	Percent hospital mortality for pneumonia cases	Percent one-year mortality for pneumonia cases	Total hospital costs (in thousand dollars) for pneumonia cases	Average costs (in dollars) per pneumonia separation
1	5.49	9.60%	1.16%	1.07 (1.10)	8.74 (6)	17.52%	10.5%	24.0%	$12,086	$4,266
2	5.94	10.61%	1.98%	1.13 (1.09)	9.95 (6)	15.50%	11.1%	25.0%	$8,162	$4,371
3	5.39	6.02%	4.09%	1.03 (1.05)	7.76 (5)	19.11%	8.9%	23.6%	$5,850	$4,350
4	2.74	9.33%	2.40%	1.27 (1.15)	9.96 (7)	14.85%	13.7%	29.3%	$45,031	$5,169
5	6.56	3.43%	0.75%	0.80 (0.91)	7.96 (5)	16.28%	7.5%	20.4%	$4,537	$3,791
6	6.17	8.34%	1.30%	0.88 (0.97)	9.30 (6)	18.01%	10.4%	22.7%	$15,685	$3,989
7	7.39	3.86%	1.09%	0.78 (0.94)	7.64 (5)	17.35%	7.6%	19.1%	$9,754	$3,555
8	4.02	5.01%	1.48%	0.91 (1.04)	8.40 (5)	20.73%	8.7%	25.1%	$5,083	$4,173
9	10.65	10.01%	1.58%	0.87 (0.95)	8.12 (5)	18.98%	9.2%	23.6%	$5,525	$3,790
10	3.28	10.61%	3.01%	1.36 (1.21)	11.07 (7)	16.42%	17.1%	34.1%	$53,683	$5,524
11	6.90	4.93%	0.87%	0.78 (0.96)	7.89 (5)	18.72%	7.5%	19.9%	$7,091	$3,642
12	7.87	5.92%	0.87%	0.89 (0.99)	7.20 (5)	20.53%	7.9%	23.1%	$11,188	$3,874
13	5.24	5.58%	0.83%	0.79 (0.92)	7.45 (5)	17.15%	8.0%	20.5%	$5,736	$3,682
14	9.69	6.57%	0.30%	0.68 (0.88)	6.61 (5)	19.87%	5.9%	18.4%	$2,387	$3,562
15	10.72	3.75%	0.47%	0.61 (0.94)	5.17 (3)	19.13%	3.6%	11.6%	$2,867	$3,357
16	2.64	18.37%	0.29%	0.58 (0.82)	9.94 (6)	16.30%	7.6%	16.8%	$1,333	$3,886
17	6.88	2.25%	0.56%	0.50 (0.80)	6.46 (4)	13.91%	29.7%	13.1%	$1,156	$3,256

Table: Service region use of hospital care for community-acquired pneumonia during 1994/95 to 1998/99

Service region	Total number of hospital separations	% Special care unit admissions for pneumonia cases	% Alternate level of care designation for pneumonia cases	Average (standard deviation) number of comorbidity for pneumonia cases	Mean (median) length of hospital stay in days for pneumonia cases	Percent thirty-day re-admissions after discharge for pneumonia	Percent hospital mortality for pneumonia cases	Percent one-year mortality for pneumonia cases	Total hospital costs (in thousand dollars) for pneumonia cases	Average costs (in dollars) per pneumonia separation
1	2,791	9.67%	1.11%	1.08 (1.10)	8.5 (5)	17.1%	10.7%	24.6%	$11,901	$4,264
2	1,901	10.57%	2.05%	1.12 (1.10)	9.95 (6)	16.3%	11.0%	24.7%	$8,238	$4,333
3	1,227	3.99%	5.05%	1.02 (1.05)	7.66 (5)	19.4%	7.9%	23.7%	$5,051	$4,116
4	8,885	9.80%	2.32%	1.28 (1.15)	9.97 (7)	14.8%	13.7%	29.0%	$46,594	$5,245
5	1,165	1.55%	0.69%	0.77 (0.91)	7.40 (5)	16.0%	7.6%	20.7%	$4,156	$3,567
6	3,607	9.01%	1.44%	0.89 (0.97)	9.77 (6)	17.5%	11.0%	23.8%	$14,399	$3,992
7	2,767	2.82%	1.19%	0.76 (0.93)	7.59 (5)	17.1%	7.6%	19.2%	$9,531	$3,444
8	1,012	0.99%	1.09%	0.85 (0.97)	7.51 (5)	18.5%	5.9%	22.5%	$3,888	$3,841
9	1,559	8.53%	1.67%	0.75 (0.89)	7.27 (5)	19.2%	7.1%	19.2%	$5,409	$3,469
10	10,426	11.91%	2.85%	1.38 (1.22)	11.09 (7)	17.4%	16.6%	33.6%	$58,874	$5,647
11	1,703	3.17%	0.70%	0.64 (0.84)	7.53 (5)	17.6%	6.9%	19.1%	$5,482	$3,219
12	2,590	4.29%	0.89%	0.84 (0.93)	6.84 (5)	20.1%	7.3%	22.1%	$9,168	$3,540
13	1,595	5.52%	0.63%	0.78 (0.91)	7.37 (5)	17.4%	7.5%	19.7%	$5,860	$3,674
14	734	5.99%	0.41%	0.72 (0.91)	6.75 (5)	20.4%	6.3%	20.7%	$2,514	$3,424
15	778	2.57%	0.51%	0.54 (0.86)	4.67 (3)	15.8%	3.6%	9.5%	$2,394	$3,077
16	334	19.16%	0.30%	0.55 (0.82)	10.18 (6)	17.0%	7.5%	16.47%	$1,267	$3,793
17	342	0.00%	0.29%	0.46 (0.75)	5.93 (4)	13.6%	3.1%	12.3%	$1,041	$3,044
Other	226	0.00%	1.33%	1.48 (0.78)	13.99 (7)	34.1%	25.8%	68.6%	$1,387	$6,138

Table: Total hospital separations during 1994/95 to 1998/99 for community-acquired pneumonia in individual Alberta hospitals (Continued)

Facility Name	Separations
Edmonton Royal Alexandra	4,066
Calgary Foothills Provincial	3,039
Calgary General (Bow Valley and Peter Lougheed)	2,847
Calgary Rockyview General	2,757
Edmonton University Of Alberta	2,464
Edmonton Grey Nuns	1,454
Red Deer General Hospital	1,365
Lethbridge Regional Hospital (General)	1,253
Edmonton Misericordia	1,185
Medicine Hat Regional Hospital (General Centre)	1,135
Wetaskiwin General	1,103
St. Albert Sturgeon General	794
Grande Prairie Queen Elizabeth II (General)	638
Camrose St. Mary's	539
Brooks Health Centre	464
Leduc General	461
Drayton Valley General	444
Stony Plain Municipal	434
High River General	429
Ponoka General	410
Vegreville St. Joseph's General	389
Rocky Mountain House General	383
Lacombe General	371
Innisfail Health Care Centre (General)	362
Westlock Immaculate	343
Fort McMurray Regional	334
Athabasca General and Auxiliary	330
Slave Lake General	327
Barrhead General	327
Olds Municipal	322
McLennan Sacred Heart	318
Elk Point Municipal	309
Strathmore Valley General and E.C.C. (General)	308
Fort Saskatchewan General	306
Lac La Biche (W.J. Cadzow General Centre)	286
St. Paul St. Therese General	286
Mayerthorpe General	285
Daysland General	285
Cardston Municipal	285

Table: Total hospital separations during 1994/95 to 1998/99 for community-acquired pneumonia in individual Alberta hospitals (Continued)

Facility Name	Separations
Peace River Municipal	282
Drumheller Regional Health Complex (General)	280
High Prairie Region Health Complex	263
Tofield Health Centre (General)	249
Pincher Creek Municipal Hospital	245
Stettler General	237
Bonnyville Health Centre	234
Three Hills Health Care Centre (General)	234
Viking General	233
Calgary Holycross	229
Fairview General	225
Vermilion Health Care Complex (General)	219
Canmore Municipal	216
Wainwright and District H.C.C. (General)	216
Black Diamond, Oilfields General	215
Fort MacLeod Health Care Centre	214
Edmonton Cross Cancer Institute	212
Fort Vermilion St. Theresa General	207
Beaverlodge Municipal	205
Didsbury Mountain View H.C.C. (General)	200
Edson St. John's	199
Whitecourt General	196
Devon Civic	195
Desmarais/Wabasca General	188
Taber and District Health Care Complex (General)	183
Sundre General	178
Blairmore Crowsnest Pass General	173
Cold Lake Regional Hospital General Centre	173
Boyle General	169
Grimshaw, Berwyn and District	167
Redwater General	156
Vulcan General	156
Raymond General	152
Killam General	151
Spirit River Central Peace General	144
Hanna General	142
Hinton General	140
Rimbey General	139
High Level Community Health Centre	135

Table: Total hospital separations during 1994/95 to 1998/99 for community-acquired pneumonia in individual Alberta hospitals (Continued)

Facility Name	Separations
Manning Municipal	134
Claresholm General	133
Lamont Archer Memorial	129
Bow Island Health Centre (General Centre)	128
Milk River Border Counties General	127
Valleyview Health Centre	126
Smoky Lake George McDougall Memorial	122
Coronation Municipal	118
Mannville Municipal	112
Two Hills Health Care Centre (General)	107
Castor Our Lady Of The Rosary	105
Oyen Big Country	91
Provost Municipal Health Care Centre	83
Bassano General	82
Hardisty General	81
Banff Mineral Springs	78
Magrath Municipal	77
Grande Cache General	67
Coaldale Health Care Centre (General)	61
Consort Municipal	48
Lloydminster General	47
Jasper Seton General	44
Galahad General	39
Glendon Municipal	32
Fox Creek Hospital	31
Trochu St. Mary's Health Care Centre	30
Vilna Our Lady's	30
Hythe Municipal	23
Swan Hills General	22
Picture Butte Municipal	21
Bashaw General	17
Cardston Blood Indian	14
Myrnam Municipal	13
Eckville Municipal	13
Breton General	12
Calgary Alberta Childrens	11
Elnora General	10
Willingdon Mary Immaculate	10
Mundare Mary Immaculate	8

Table: Total hospital separations during 1994/95 to 1998/99 for community-acquired pneumonia in individual Alberta hospitals (Continued)

Facility Name	Separations
Bentley General	7
Islay Municipal	5
Calgary Salvation Army Grace	2
Edmonton Charles Camsell	2
Empress Municipal	1
Cereal Municipal	1

BIOGRAPHIES

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As a demographer, Yan Jin is interested in applying demographic and statistical techniques in health field, particularly in population health and health service utilization. He has taught demographic techniques at the University of Alberta.

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K. Carrière's area of application is in health services research, where her contribution in this area led her to win the National Health Scholar Award (1996-2001) from the National Health Research and Development Program (NHRDP). She is a Senior Scholar with Alberta Heritage Foundation for Medical Research (AHFMR) (1999-2004) and is currently funded by NSERC, MRC, NHRDP, AHFMR, and NCIC.

K. Carrière is an elected board member of the Western North American Region of International Biometrics Society (2000-2002), past member of its regional advisory board, elected Executive member for the Section on Health Policy Statistics of the American Statistical Association (1999-2001).

K. Carrière organized, chaired, invited and contributed paper sessions at major national and international conferences, including the Edmonton Statistics and Health conference which was held in June 2000.

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Major responsibilities include managing health protection programs and monitoring and reporting on the health status of the population. Annually, Dr. Predy produces a health status report entitled "How Healthy Are We?" which makes use of population health indicators and the influence of the determinants of health.

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As a physician, Dr. David Johnson's clinical practice is affected by the health care system. Dr. Johnson is interested in understanding and promoting the use of information in directing health policy formation and decision making by the managers of the health care system.

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Summary of "Variation in Management of Community-Acquired Pneumonia Requiring Admission to Alberta Hospitals"

By Y. Jin, T. Marrie, K.C. Carrière, G. Predy, C. Houston, K. Ness and, D. Johnson

Purpose

Community-acquired pneumonia is a common reason for hospital admission with clinical variability in the decision to admit or discharge from hospital. This study determines the rates of admission and length of stay for patients with community-acquired pneumonia in Alberta. Factors influencing the admission rates and the length of stay for community-acquired pneumonia are assessed.

Approach

Using Alberta Health and Wellness hospital abstracts, hospital admissions for community-acquired pneumonia from April 1, 1994 to March 31, 1999 are compared. Rates of hospital discharges and length of hospital stay are calculated. Alberta hospitals are classified according to geographic regions, by the number of beds, and by number of community-acquired pneumonia cases.

Key findings

The following are key findings of this study:

- There were 12,000 annual hospital discharges for community-acquired pneumonia costing over forty million per year.
- Fourteen percent of patients had repeated hospital admissions during the five years.
- Forty-two percent of all hospital admissions occur within the December to March winter period
- Hospital discharges decreased by eight percent in 1995/96 compared to 1994/95 and were four percent 1998/99 compared to 1994/95.
- The overall in-hospital mortality rate was twelve percent and the one-year mortality rate was twenty-six percent.
- Compared to rural hospitals, regional and metropolitan hospitals admitted sicker patients who stayed in hospital for a longer duration, died more often, and used more resources per patient.
- Age-sex adjusted hospital discharge rates were significantly below the provincial average in both urban regions (Calgary and Capital) and not different from the provincial average in one of five regions with a regional hospital.
- Age-sex adjusted hospital discharge rates for residents in all other regions were significantly higher than the provincial average.

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- After adjusting for other factors, the relative risk for a longer duration of hospital stay was twenty-two percent greater in regional hospitals and about thirty percent greater in urban hospitals compared to rural hospitals

Conclusions

Utilization analysis may be helpful in targeting quality improvement initiatives specific to the need of different hospitals and health regions. The existing practice environment in rural regions and some health regions with a regional hospital make the appropriateness of hospital admission a better quality improvement target. The existing practice environment in urban regions make the length of hospital stay (i.e. time between hospital admission and discharge) a target for quality improvement. Regional hospitals have an increased length of stay and most have a higher admission rate so the decision to admit and discharge may both be quality improvement targets.

Quality improvement initiatives for community-acquired pneumonia should be targeted towards reducing the admission rate at rural hospitals and shortening the length of stay at urban and regional hospitals.

For more information

Copies of the report are available from the
Alberta Centre for Health Services Utilization Research

- by contacting David Johnson by e-mail at cujecjohnson@shaw.ca
- at http://www.health.gov.ab.ca/system/key/Research/achsur_reports.html

Alberta Centre for Health Services Utilization Research

The Alberta Centre for Health Services Utilization Research is a joint initiative between the University of Alberta and the University of Calgary, funded by Alberta Health and Wellness. The Centre conducts studies of how health services are used and delivered to inform health policy development and management of health services delivery.

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